DEPARTMENT OF THE INTERIOR

FRANKLIN K. LANE, SECRETARY

BUREAU OF MINES

VAN. H. MANNING, DIRECTOR

IN COOPERATION WITH

THE STATE OF OKLAHOMA

UNDERGROUND PROBLEMS
IN THE
COMANCHE OIL AND GAS FIELD
STEPHENS COUNTY, OKLAHOMA.

BY

T. E. SWIGART

SEPTEMBER, 1919

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UNDERGROUND PROBLEMS IN THE COMANCHE OIL AND GAS FIELD, STEPHENS COUNTY, OKLAHOMA.

By

T. E. SWIGART.

PURPOSE AND SCOPE OF THE REPORT.

This paper deals with one branch of the work done by the Bureau of Mines at the Bartlesville station, namely, the study of a producing oil and gas field with the view to promoting more efficient and less wasteful operation. The area chosen for study was the Comanche oil and gas field; its production is still negligible, but the process of development in the early stages has offered wide scope for the work of the engineer. Results of the investigation are presented in this report. Its purpose is to point out how certain applied engineering methods will aid in making the development of an area safer, more economical, and the wells more productive. Mention is made of geologic features only when necessary to clarity of discussion.

Attention is called to Bulletin 195, "Underground Conditions in Oil Fields," by A. W. Ambrose* which covers in a thorough, yet concise manner, the most up-to-date engineering practices of large corporations on their drilling and producing properties. The work at Comanche was conducted along the lines described by Mr. Ambrose, and as many of the ideas as were applicable were followed out.

Aided by the regularity of the formations and prolific sands, the operators of northern and eastern Oklahoma have had considerable success without the help of underground engineering, but even in these fields many glaring examples of waste and inefficiency, caused by improper development methods, justify the employment of a practical engineer. With the discovery of Healdton, Fox, Walters, and other similar fields, the need for sounder policies of development has become greater and certain companies have already assigned resident geologists or engineers to this work. Comanche is another area with lenticular sands and was chosen as a starting point for the work in Southern Oklahoma. This field was in the stage of active development and because of the increasing amount of trouble, the

*Ambrose, A. W., Underground Conditions in Oilfields, Bull.195, Bureau of Mines (in course of publication).

writer gave it detailed attention. The first part of the paper deals with the general conditions at Comanche, and outlines the nature of the work attempted. Under the Geologic Structure of the Comanche Field the few remarks on the geology of the region are meant to give the reader an idea of the kinds of formations encountered. The description of the structure and the use of the contour map and composite log is given with the idea of determining the productive horizons, as well as of showing the successive water, gas and oil sands and the depths at which they may be expected in new wells.

The discussion of the Wilson formation should prove of interest as the lenticular character of these sands has already cost the operators a number of dry holes. Brief descriptions of the various water, gas and oil sands are also given as they form the only important key beds with the data at hand.

As regards drilling methods, and the merits of standard and rotary tools, the writer acknowledges a very useful field for both cable and rotary drilling methods.

Such matters as deepening, shutting off water, proper depths at which to land casing, shooting, etc. all merit the attention of the engineer, and the discussion given represents the views of many practical men.

The writer discusses gas, oil and water analysis and offers a few suggestions on the usefulness of water analyses in development.

ACKNOWLEDGMENTS.

The writer is pleased to acknowledge the cordial cooperation of Messrs. J. E. Keller and J. Z. Zimmerman, of the Comanche Petroleum Company, and of Messrs. E. E. Gilbert and Roy Irick, of the Magnolia Petroleum Company. To Messrs. J. G. Beard, George Bowden, D. R. Jones, J. L. Crump, G. H. Terry, R. Riggins, J. H. Acord, William Richardson, Joe Hartmangruben and Ralph Tibbons thanks are tendered for their assistance and cooperation.

Acknowledgment is due the following members of the Bureau of Mines for their aid and constructive criticisms:- Messrs. J. O. Lewis, W. P. Dykema, A. W. Ambrose, H. B. Hill, E. W. Wagy, F. B. Tough, A. A. Hammer and R. E. Collom. The analyses of oil, gas and water samples were made by Messrs. R. O. Neal, Donald B. Dow, and Marcellus Law.

GEOLOGIC STRUCTURE OF THE COMANCHE FIELD.

General Notes on Geology and Structure:

Comanche, like other areas, such as the Walters field, Loco and West Duncan field is in the "Red Bed" region. The structure

is that of a dome-like anticline having a northwest trend; flat noses extend towards the northwest and southeast but the flanks on the northeast and southwest dip steeply. The direction and amount of dip of the Permian red beds in southern Oklahoma is the source of much argument and speculation among geologists and so far has not been determined to everybody's satisfaction.* Determination of the major structure is difficult because well defined outcrops are few.

No fossils have ever been found in the shallow wells, but in the drill cuttings of the Frank Perry 1 on Section 18, T2S, R7W, a few crinoid stems were found at 2000 feet. This is deeper than the Pennsylvanian contact is believed to be, but other information leads one to believe that the drill penetrates Pennsylvanian beds at about 1200 feet.

The structure of the oil-producing formation may be described as an anticlinal dome, although the lack of well data east and north of town makes the determining of the closure impossible. The axis of the fold has a northwest strike, like that of most folds wouth of the Wichita and Arbuckle Mountains.

The crest of the dome lies in the N. W. quarter of Section 20, T2S, R7W. Clara Wilson 1 and Clara Wilson 4 are evidently at the highest points, the Wilson sand in these wells being just 307 feet below sea level.

The northwest and southeast extensions of the structure dip much more gradually than the northeast and southwest flanks and should furnish the best areas for development. The northwest sector has already shown more promise than any of the other flanks, but unfortunately the Susan Perry well showed to such a poor advantage that development to the southeast has been neglected.

If the sand was uniform in texture, porosity, and thickness the wells on that part of the structure which drains long flatly dipping flanks would be expected to have the greatest source of supply and be longest lived. At Comanche this is not exactly true; the Carter wells are on a steep flank and their productivity results from favorable sand conditions. In the southeast sector the location of the Susan Perry well was structurally good for finding an accumulation of gas and oil, but the test was far from encouraging as the Wilson sand carried no oil or gas, and the oil sand at 1559 feet seemed to carry both oil and salt water.

The Stratigraphic Contour Map:

The most satisfactory contour map would be one whose contours represented the surface of the producing sand and almost as satisfactory would be one whose contours represented the surface of a continuous and easily recognized bed at a known interval

*Bulletin 19, Oklahoma Geological Survey, Part II. Hager, Lee, Oil and Gas Journal, Oct. 17,1919, Geology of the Red River Country.

not far above the producing sand. Whether such a continuous layer exists at Comanche is hard to decide as the rotary logs do not give sufficiently accurate data. At one time in the work the writer found the contact of overlying shales with massive sandstone at 315 feet above the Wilson formation. This sandstone continues almost uninterrupted for 80 or 100 feet in a number of logs in the southwest corner of Section 17 and northwest corner of Section 20, but in other parts of the field it either does not exist or the rotaries have failed to find it. The need for such a marker is evident because the Wilson sand is not a continuous, but rather a number of lenticular sands. For this reason the Wilson sand can not be contoured, and so the entire area was worked up on what will be termed the Wilson formation. Whether this is a definite formation, can not be said. At places the appearance of a grey shale or sandy shale in the drillings indicated that a definite formation does exist, whereas in other parts of the field only a thin bed of oil sand appears between successive layers of shale or gumbo, as in the T. A. Edmunds well in Section 12, T.2,S., R.8.W. Attention is here called to the extent of the 850-foot gas sand, which seems to appear in practically every well log and is the most definite upper marker found. This sand greatly aided in solving the detail of the lenticular sands in Sections 17 and 18, T.2.S., R.7.W., and also proved another fact, namely that the producing part of the Wilson formation thickens and thins in different parts of the field.

As a contour map could not be constructed with the actual producing sands as a base, but the contours had to be made on a regularly dipping surface which, in this case, is termed the top of the Wilson formation. If at places this formation seemed imaginary, its theoretical top was determined by aid of the upper sands, and that point taken as a basis for constructing the contour map. The contours thus show the true shape and dip of the anticlinal structure and are not influenced by the thinning of layers or by discontinuous sands.

Use of Contour Map in Future Development:

As explained above, the depth of the Wilson formation does not show the depth at which oil will be found in every part of the field. But certainly, oil from the Wilson sands should not occur at a shallower depth than that shown by the map, hence the map will be a safeguard against passing through the producing sand. By intelligent application of known facts, a certain interval can be added to the depth shown by the contours to obtain more nearly the true depth of the oil for any certain locality. This interval changes in various parts of the field and Plate II illustrates how it can be determined for the S. W. $\frac{1}{4}$ of section 17, T2S, R7W. The following is the procedure in the case of a new location, where it is desirable to estimate the depth of the oil sand and from that the depth of certain markers above.

COMANCHE OIL AND GAS FIELD

STEPHENS COUNTY OKLAHOMA

STRUCTURAL CONTOURS ON TOP OF WILSON FORMATION

COMPOSITE LOG

By T.E. SWIGART

U.S. BUREAU OF MINES - PETROLEUM EXPERIMENT STA.

BARTLESVILLE OKLAHOMA

Scale 1" = 1000' Contour Interval - 10'

Accompanying REPORT of September 18, [illegible]

T2S R8W

T2S R7W

H.M. KINPATRICK — Foster Wilson — Dept. L

T.A. EDMONDS — Dept. L — Foster Wilson — 1(W Edmonds) 1.

A.L. BRANCH & C.S. WADE — J.B. Walton

Max Kinnas

MAGNOLIA PET. CO. — Com. L — Clara A. Brown — Dept. L — Pushmataha Dobbs — Dobbs

C.F. Ivey

Sam Pollard

No Lease — Clara A. Brown

S.S. KOWRI — Com. L — Clara A. Brown

W.W. Hawkee

G.W. Mayo

Byron Norman

12 — 7 — 8

C.P. BARBER — Dept. L — Frances Fobb — Frances Fobb

PATSY OIL CO — Dept. L. — Frances Fobb — (NW Patsy 1)

PRAIRIE OIL & GAS — Com. L. — I.T. Bond

No Lease — I.T. Bond

THE CARTER OIL CO — Henry Halder

J. HAMMONDE — Nancy Perelee

COMANCHE PETROLEUM COMPANY — Dept. L — Alice Isaac — Dept. L — Susan Johnson.

Olred Dirks

THE CARTER OIL CO. — Com. L. — Polly S. McMasters

COMANCHE PET CO — Com. L — F.W. Moore

No Lease — Floyd S. Moore

R.S. Bristow

Com. L.

Ode McMasters

THE CARTER OIL CO. — R.S. Bristow

COMANCHE PET. CO. — Frank Perry

400

S.A. DOYLE & WIFE — FRANKLIN — Com. L — 1/2 S. Bristow

MAGNOLIA PET. CO. — Com. L. — J.P. Reddick

HERMAN DIRKS — Dept. L — Kisson Bolliest

D.D. McDonald

13 — 18 — 17

W.W. CLEMMONS — Com. L — Ruby Marx.

THE CARTER OIL CO — D.D. McDonald

No Lease — Alice Bristow

CHAS. H. TAYLOR — Com. L. — R.S. Bristow

Davis Perry

350'

COMANCHE PET. CO. — Com. L — Grace E. Carter

EXCHEQUER PET. — Com. L — R.S. Bristow

Clara Wilson Com. L.

MAGNOLIA PET. CO. — Com. L. — Grace E. Carter

PLAINS OIL & GAS — Com. L — Laura McDaniel

Frankie Wilson

MAGNOLIA PET CO — Com. L. — Frankie Wilson

CHICAGO — ROCK ISLAND

E.M. RALLS ET AL — COMANCHE PET — Dept. L. — Edw. Barnett

C. Andreae

COMANCHE PET. CO. — Com. L

J. Wilson 3

C.W. 4 — C.W. 1 — Com. L

Clara Wilson Forty

310'

COMANCHE PET. CO — Dept. L.

Tennessee Alexander

MAGNOLIA PET. CO. — Chas. Andreae

Andreae 1. — Osage 1.

PRAIRIE OSAGE OIL & GAS Lease 1 — Edw. Barnett

L. Johnson

24 — 19 — 20

MAGNOLIA PET. — G.S. Brown

COMANCHE PET. CO — Alice Isaac

350'

400'

450'

J.D. Wilson

COMANCHE PET. CO. — Emma Harrison — Dept. L. — Dept. L.

Susan Perry

TEXAS CO

P.H. PECK ET. AL. — Dept. L — A. Newman

W.S. BRODERICK & G.S. HARRISON — Com. L — G.S. Brown

J.E. KELLER — C.F. Ivey — No Lease — L.W. Stowers — No Lease — L.C. Cotner

Russell Cotner

TH McMANUS — Com. L — Ned New

COMANCHE PET. — Dept. L. — Edw. Burnett

COMANCHE PET. CO — Com. L — J.D. Wilson

COMANCHE PET. — Com. L — L.L. Wilson — 14

KEOUGHAN & HURST — Lease Defaulted — J. Colbert

Chris Kobel

COMANCHE PET. CO. — Jasper Colbert — Dept. L

THE CARTER OIL CO. — Dept. L. — F. Alexander

J.E. McMillan

Maud E. Bagley

25 — 30 — 29

COMANCHE PET. CO — Com. L — W.G. Enloe

COMANCHE PET. CO — Com. L — Lillie L. Wilson

COMANCHE PET. CO — Dept. L — Leolena Johnson

COMANCHE PET. CO — Com. L — J.E. Truett

COMANCHE PET. CO — Com. L. — F.F. Wilson

COMANCHE PET. CO — Dept. L

COMANCHE PET. CO — Com. L — J.B. Wilson — 15

Fanny M. Morrison

L. Johnson 2

Cotton Beacon — J.H. Welden — Cotton Beacon

Josephine Watson

W.A. Yates — W.C. Enloe — MAGNOLIA PET CO. — J.B. Box

COMANCHE PET. CO — Com. — Ware Enloe — Com. — W.G. Enloe

Mayo Enloe

Wm. Enloe

W.G. Enloe

Wisey Bunnup

36 — 31 — 32

Susan Perry

J.E. KELLER — 17 — A.L. Wilson

A.L. Wilson

18

LEGEND

- Location
- Rig
- Driller
- Idle Driller
- Gas Producer
- Oil Producer
- Gas and Oil Producer
- Abandoned - Dry Hole
- Abandoned Show Oil
- Abandoned Water Oil
- Abandoned Producer

Elevations on Derrick floor

Note: Contours drawn on top of Wilson formation where below Sea Level

COMPOSITE LOG

T.A. Edmonds Sec. 12-T.2S-R.8W — Surface — 1170'

Patsy Sec. 7-T.2S-R.8W — Surface — 955'

Prairie Oil & Gas Sec. 7-T.2S-R.7W — Surface — 853'

Porter Oil Co. Sec. 18-T.2S-R.7W — Surface — 505'

Clara Wilson 1 Sec. 18-T.2S-R.7W — Surface — 443'

Clara Wilson 2 Sec. 18-T.2S-R.7W — Surface — 336'

Clara Wilson 3 Sec. 18-T.2S-R.7W — Surface — 315'

Carter 1 Sec. 17-T.2S-R.7W — Surface — 214'

Carter 2 Sec. 17-T.2S-R.7W — Surface — 135'

Clara Wilson 1 Sec. 20-T.2S-R.7W — Surface — 65'

Clara Wilson 2 Sec. 20-T.2S-R.7W — Surface — TOP WILSON FORMATION

Clara Wilson 3 Sec. 19-T.2S-R.7W — Surface — 22'

Williams 1 Sec. 20-T.2S-R.7W — Surface — 285'

Comanche Park Sec. 20-T.2S-R.7W — Surface — 165'

Susan Perry Sec. 20-T.2S-R.7W — Surface — 250'

Sec. 29-T.2S-R.7W — Surface — 454'

Lucille Johnson Sec. 29-T.2S-R.7W — Surface — 760'

Sec. 32-T.2S-R.7W — Surface — 843'

Sec. 30-T.2S-R.7W — Surface — BOTTOM

Sec. 31-T.2S-R.7W — Surface

Sec. 36-T.2S-R.7W — Surface

Sec. 25-T.2S-R.8W — Surface

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Sec. 32-T.2S-R.7W — Surface

Sandy Shale

Sand

Lime

Lime shells

Water Sand

Sand Show Gas

Sand Show Oil

Gas Arbuckle Sand

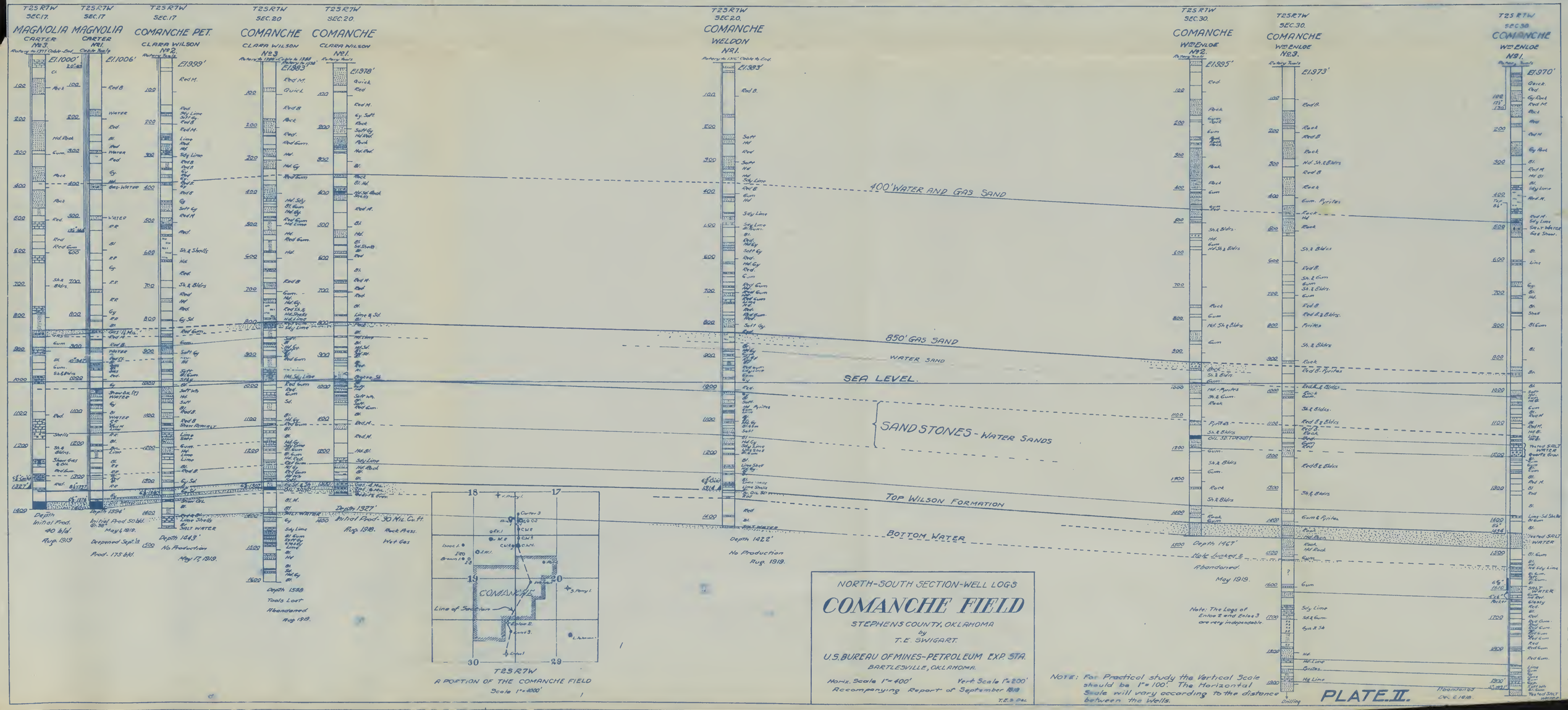
Oil Sand

Formations of no interest

Note: Only the sands which occur in holes used as markers are shown.

To find depth of any marker - ADD number shown opposite marker to depth of Wilson formation

SUBTRACT number opposite marker to find depth of any marker from depth of Wilson formation



T2SR7W SEC.17. MAGNOLIA CARTER No.3. El.1000'
T2SR7W SEC.17 MAGNOLIA CARTER No.1. El.1006'
T2SR7W SEC.17 COMANCHE PET. CLARA WILSON No.2. El.1999'
T2SR7W SEC.20 COMANCHE CLARA WILSON No.3 El.1983'
T2SR7W SEC.20. COMANCHE CLARA WILSON No.1. El.1978'
T2SR7W SEC.20. COMANCHE WELDON No.1. El.1983'
T2SR7W SEC.30. COMANCHE Wm ENLOE No.2. El.1995'
T2SR7W SEC.30. COMANCHE Wm ENLOE No.3. El.1973'
T2SR7W SEC.30 COMANCHE Wm ENLOE No.1. El.1970'
400' WATER AND GAS SAND
850' GAS SAND
WATER SAND
SEA LEVEL.
SANDSTONES - WATER SANDS
TOP WILSON FORMATION
BOTTOM WATER
Depth 1327' Initial Prod. 30 Mil. Cu.Ft. Aug. 1918. Rock Press. Wet Gas
Depth 1443' No Production May 17, 1919.
Depth 1598 Tools Lost Abandoned Aug 1919.
Depth 1422' No Production Aug. 1919.
Depth 1467' Hole Junked & Abandoned May 1919.
Note: The Logs of Enloe 2 and Enloe 3 are very independable.
Line of Section
COMANCHE
T2SR7W
A PORTION OF THE COMANCHE FIELD
Scale 1"=4000'
NORTH-SOUTH SECTION-WELL LOGS
COMANCHE FIELD
STEPHENS COUNTY, OKLAHOMA
by
T.E. SWIGART.
U.S. BUREAU OF MINES-PETROLEUM EXP. STA.
BARTLESVILLE, OKLAHOMA.
Horiz. Scale 1"=400' Vert. Scale 1"=200'
Accompanying Report of September 1918
NOTE: For Practical study the Vertical Scale should be 1"=100'. The Horizontal Scale will vary according to the distance between the Wells.
PLATE II.

(1) Take the elevation of ground where the hole is to be drilled and add two or three feet to make elevation approximately that of derrick floor.*

(2) Correctly locate the well in the field with reference to nearest section, half or quarter section corner, then plot to scale on the map.

(3) Add elevation of well to the figure obtained by reading between the two nearest contours between which the well lies, the result being depth of the top of the Wilson formation.

(4) If location is in a part of the field where the producing sand is suspected to lie at the top of the Wilson formation, as it does in the vicinity of Clara Wilson 1 and 4, John Wilson 1 and 2, Exchequer and Alice Isaac wells, the figure obtained in (3) should be the depth of the producing sand. However, for a well drilled in a location such as that of Carter 3, section 17, T2S, R7W, 350 feet north of Carter 1, the depth shown by the map would not be the depth of the oil sand, so an interval of about 25 feet should be added to give more nearly the true depth of the oil sand. Adding such an interval is made necessary by the irregularity of the producing sand between Clara Wilson 1 amd Carter 3, and the occurrence of the new lens of oil sand.**

In drilling a new location in any part of this field the operator should observe the utmost caution in going below the point estimated from the contour map, as gas or oil may be found at any depth below. With rotary tools a gas sand is hard to recognize and every sand encountered near the depth of the producing zone deserves a thorough test by washing and bailing before it is cased off.

Use of Composite Log:

The composite log shown on Plate I should aid in determining the depths of various markers. It shows the intervals between these sands or limes indicated from a study of all logs in the field. For instance, an upper water and gas sand may be expected about 940 to 955 feet above the Wilson formation, the 850-foot gas sand occurs 500 feet above the Wilson formation and a contact between shales and underlying heavy sandstone members lies at 313 feet above the Wilson formation.

To make use of this log in preparing a list of markers to be looked for in any new drilling well, first determine the depth of the Wilson formation by adding the elevation to the figure read from the contour map, then subtract or add from the depth so determined, the intervals shown on the composite log. The list should be checked by aid of a section of well logs, then pasted in the log book or tacked in a conspicuous place in the derrick.

NOTE:- See footnotes at top of following page.

*All elevations are taken on derrick floor because measurement of depths are from floor. The floor also gives a definite bench mark which does away with all confusion as to where elevation is taken. Until the rig is built, however, two or three feet added to ground elevation will give the elevation of the derrick floor very closely.

**See Plate II, also page 4.

The following example illustrates the procedure followed in determining depths, etc. in the proposed location for Isaac 2, Section 19, T2S, R7W:

Ground elevation above sea-level	1003.7	taken in field
Add, say, 2½ feet for height of derrick floor	2.5	
Elevation on derrick floor	1006.2	
Depth of Wilson formation	392	feet from contour map
Depth from derrick floor to top of Wilson formation	1398	feet (by addition)

Depth of Wilson formation	1398	feet
Interval to upper gas or water sand	944	feet from composite log
Depth to top of upper gas layer	454	feet (subtracting)

Depth of Wilson formation	1398	feet
Interval to 850-foot gas sand	498	feet from composite log
Depth to top of 850-foot gas layer	900	feet (subtracting)

Depth of Wilson formation	1398	feet
Interval to top of next gas or water sand	290	feet
Depth to top of sand	1008	feet (subtracting)

Depth of Wilson formation	1398	feet
Interval to heavy sandstone layer	315	feet
Depth to sandstone contact	1083	feet

Depth of Wilson formation	1398	feet
Interval to first oil sand layer	85	feet
Depth to first oil sand	1313	feet

Depth of Wilson formation	1398	feet
Interval to bottom water sand	80	feet (or more)
Depth to bottom water sand	1478	feet (approx.) adding.

Depth to top of Wilson formation	1398	feet
Interval to 1800-foot oil sand	454	feet
Depth to 1800-foot oil sand	1852	feet(adding)

After these computations have been made and checked, if possible, bysections, a driller's memorandum should be made in duplicate in some such form as shown below.

"To Drillers of Isaac 2:

You may expect the following sands to occur at or near depths given below. Upon nearing these depths please watch formations closely.

Elevation on derrick floor.....1006 feet
Depth to:
1. Shallow gas or water sand..... 454 feet
2. 850-foot gas layer..... 900 feet
3. Gas or water sand.....1008 feet
4. Top of a thick sandstone layer.....1083 feet
5. Top of first oil sand.....1313 feet
6. Wilson formation.....1398 feet
Do not drill deeper than.....1440 feet
without permission.

(Signed)_____
Superintendent."

Accuracy of Contour Map:

The accuracy of the contour map will be found to differ in different parts of the field, being dependent upon certain factors such as proximity of new location to wells already drilled, correctness of the logs, spacing of the wells, etc. Where correlation is uncertain, the contours are dotted in.

Future development will be necessary before this entire area can be contoured with certainty, but it is hoped that the work so far done in uncertain sectors will be of some aid in locating the producing horizons. If development is followed closely, no mistakes would probably be made with the data on hand, and by degrees the entire area can be worked up with certainty.

Accuracy of the Composite Log:

All the formations shown on the composite log can not be expected in every well, because there are not many continuous formations in Comanche, and, the information used in compiling the composite section came from rotary logs which are known to be unreliable.

The number of sands that may be expected and the depths at which they will occur is well illustrated by the following example. The composite log was made before John Wilson 3 was drilled so the estimated sands and depths are independent of those actually found in John Wilson 3.

JOHN WILSON 3

Sec. 19, T2S, R7W.

ESTIMATED FROM CONTOUR MAP AND COMPOSITE LOG	(Feet)	ACTUAL FORMATION RECORD (ROTARY TOOLS) OF THE WELL	(Feet)
Elevation derrick floor.....	1020		
Wilson formation below sea level...	340		
Depth to Wilson formation.....	1360	Red shale and very hard gravel.....	1360 to 1372
Max. thickness found	55	Sand.....	1399 to 1403
Bottom Wilson formation.....	1415	Oil sand.....	1403 to 1415

After determining the depth of the Wilson formation the other sand depths were computed and compared as shown below:

Water sand.....	190 to 213	Sand rock.....	205 to 215
Water and gas.....	405	Blue sand.....	399 to 425
Water sand.....	507	Hard sandy lime.....	507
850' gas layer.....	855 to 875	Gray sand.....	860 to 870
Water sand.....	917	Gray sand.....	920 to 926
Gas sand.....	964	Sandy shale.....	938 to 975
100' sandstone layer (top).....	1045	Gray sand	1041
Oil sand.....	1144 to 1164	Sandshells.....	1154 to 1160
Show of oil.....	1225 to 1248	Brown and gray sand shows oil.....	1224 to 1252
Sand, shows oil.....	1275 to 1305	Hard sand.....	1288 to 1298
- - (not found before).....	---- ----	Sand, shows oil.....	1305 to 1317
Water sand.....	1445	Hard sandy lime.....	1450 to 1460
Water sand.....	1525	Sandy lime rock and gray sand.....	1524 to 1535
Show oil or water...	1610	Hard sand and lime..	1600 to 1618
Oil sand, pay (?)...	1814	Oil sand.....	1799 to 1809

THE WILSON FORMATION.

The term Wilson formation is applied to that zone which includs gas and oil bearing sands of varying character. Although the Wilson formation seems to be a sand in certain parts of the field, in other parts, the sand seems to thin out or grade into a sandy shale. To distinguish the top of the formation in these localities would be impossible unless the approximate depth was known beforehand and a "break" or change of formation was felt by the driller at about that depth.

At one time the writer believed he had detected a fault, but feeling that this conclusion was not warranted by the data from only two wells, Carter 2 and 3, variations of interval have been attributed to the lenticular character of the oil sands. The shallow gas sand is an excellent marker and is continuous all over the field, hence considerable weight has been given to its depth in the various wells.

The possibility of the shallow gas sand and the Wilson sand being unconformable was considered, too little information is available to warrant adopting such a view.

The Wilson sand is a medium-grained, brown sand in the productive area, but is nowhere of constant thickness; 38 feet of the sand was logged in Clara Wilson 1, and 42 feet in John Wilson 1, but other wells near by found only 7 to 20 feet of "pay".

Further proof of the lenticular character of the producing sands may be found by comparing the analyses of oils from the Carter wells, Clara Wilson 1, and Isaac 1. The gravity of oil from Carter 1 was 38°Bé. and the gasoline content 27 per cent whereas oil from Clara Wilson 1, only 1500 feet away, had a gravity of 33.6° Bé, and a gasoline content of 17 per cent. Duplicate samples taken from the wells at a later date gave concordant results. This strengthens the conclusion that the Carter 1 and Clara Wilson 1, are producing from different sands. The oil samples from Isaac 1, and John Wilson 2, were about the same grade as oil from the Clara Wilson 1, with gravities of 33.7° Bé. and a gasoline content of 17 per cent.*

Probable limits of producing sands in Wilson formation:

So far, the most productive oil sand is that from which the Carter 1 produces. This sand pinches out to the south and west and is dry due east, hence the only sector uncondemned is to the north.

The limits of the main body of sand from which Clara Wilson 1, John Wilson I and 2, and the Isaac well produce are hard to define. This sand must extend as far as section 24, T2S, R8W, where the well of the Osage Oil and Gas Co. struck it, but Brown 1 (in section 24, T2S, R8W) and Weldon 1 (in section 30, T2S, R7W) indicate that the sand pinches out to the south. To the

*See page 25 for analysis of Comanche oils.

northwest it seems that the Edmonds well struck the same sand near 1600 feet. Weldon 1, the Park well, and Susan Perry practically condemn the southeast sector as far as the Wilson formation is concerned and the Enloe wells apparently settle the fate of the district south of town, because the Wilson sand is known to bear salt water.

Nature of Cap Rock:

The cap rocks at Comanche vary in nature and quality and indeed no continuous layer of impervious rock exists. The existence of a hard layer over the sand is indicated in the N. W. 1/4 of section 20 and N. E. 1/4 of section 19, T2S, R7W. The Clara Wilson 1, 2, 3, and 4, the Comanche Park well, the John Wilson 1 and 2, and Isaac 1 all found rock, either hard sand or lime shell. The proper formation in which to land the casing must be determined for each individual well by "feeling ahead" with a small bit.

The Dry Offsets of Carter 1:

It is believed that the wells which offset Carter 1 to the east, south and west are not dry because of improper drilling or casing methods. It seems that the oil sand encountered at 1373 feet in Carter 1 grades into a sandy shale towards the east, south and west. In Clara Wilson 2, this sand was good for about 5 barrels per day, but in Carter 2 the sand was badly broken with shale and showed only a little oil. The shell in Carter 1 from 1365 to 1366 feet, on the other hand, seems to widen out and is logged as a sand in Clara Wilson 2, an oil sand in Clara Wilson 3, and is part of the productive horizon in Clara Wilson 1. See Plate II, page 4.

The Bristow well showed a poor oil sand from 1365 to 1370 feet. That this sand is the same as that encountered in Carter 1 also seems clear, but the presence of blue shale, seemingly as streaks in the sand, strengthens the writer's belief that the sand was grading into a sandy shale. Further west the Exchequer well and John Wilson 2 show in the top of the Wilson formation, a productive sand which is more like the productive layer encountered in Clara Wilson 1.

Clara Wilson 3 was reported dry, but it is thought that the casing is cemented too low. The well was drilled with rotary tools to 1308 feet, and the top of the oil sand was logged at 1307 feet. With the 6-5/8 inch casing cemented at 1307 feet it is not at all unlikely that the formation between 1290 and 1307 was gas bearing and indeed the well did show a little gas when drilled in.

THE 850-FOOT GAS LAYER.

The 850-foot gas layer, so called for lack of a specific name, is surprisingly continuous. Excepting in a few of the poorest logs this sand was indicated in almost every well, and it served as the best marker in helping to determine the Wilson formation. The edge-water level is of course unknown, but the Leolena Johnson 1 is so low on the flank of the anticline that the gas may extend over a considerable area. This well has not gone to water as yet. The gas was also noted in the Dirks well, Section 12, T2S, R8W, which again indicates that the sand in extensive.

Analyses of the gas from this shallow sand appear on page 26 of this report. The productivity of the shallow wells is rather encouraging as it shows the gas sand to be of considerable value.

OTHER UPPER FORMATIONS OF INTEREST.

Excepting the 850-foot gas sand and the water sands to be discussed later, the only formations of particular interest at Comanche are the oil sand 85 feet above the Wilson formation and the asphaltum sand about 214 feet above the Wilson formation.

The first sand has been logged as oil sand in three wells only, the John Wilson 1, from 1282 to 1304 feet; the John Wilson 2, from 1274 to 1281 feet; and the T. A. Edmunds from 1486 to 1500 feet; but the presence of sand at that stratigraphic depth in other wells indicates that it may be more extensive than at first believed.

The other sand was found in Susan Perry 1 at 1097 feet which correlates with the asphalt sand at 1119 feet in Clara Wilson 2. This is probably only a small lens of asphaltum sand, but no test was made on Susan Perry 1 as the geologist was not at the well when the drillers passed that formation.* Neither of these sands have been given a regular test.

UPPER WATER SANDS.*

Various water sands are found, the principal ones being shown in the log of Carter 1, Section 17. However, it must be borne in mind that (1) to find water sands with rotary tools water sands requires a special test, and (2) water will probably no be found in the same sand throughout the field, very few of the water sands being continuous.

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* See page 34 Appendix II (Record of Susan Perry 1).

** See Composite log, Plate I.

The water sands noticed are described individually below.

(1) Fresh water is found in many parts of the field in a sand overlying the Wilson formation at about 1170 feet,* although logged as water in only a few wells, the rotary drillers did log a sand at this level in probably two-thirds of the logs.

(2) About 940 feet above the Wilson formation a water and gas sand was found in Carter 1; it lies about 955 feet above the Wilson formation in Enloe 1. Although not recorded as a water sand, this sand is found in most of the logs. It is a fair marker, but lies too high to be of much value, being at 395 feet in Carter 1, 475 feet in Enloe 1 and probably at 549 feet in the Pawnee Osage well, section 24, T2S, R8W.

(3) The next water sand recorded is one at 495 feet in Carter 1, approximately 850 feet above the Wilson formation. This sand is found at the corresponding stratigraphic level in many wells, but was not recorded as a water sand except at the Carter.

(4) A water sand also occurs about 443 feet above the Wilson formation. Evidences of this sand are shown in other wells which log it as "sand".

(5) The most important upper water sand is at 1029 to 1051 feet in Carter 1. This sand is no doubt lenticular and the writer believes should not be called a water sand, but rather a water zone. At a height of 315 feet above the top of the Wilson formation, a sandstone contact, mentioned on page 4 was found in a number of wells. The thickness of the zone in which sandstones predominate is indeterminate, but seems to be about one hundred feet in a number of places. Although water was not always found at the same level in this zone, it did occur in various sands of the layer in many wells. For instance, the following wells show water sands at this stratigraphic level.**

WELL	FORMATION	DEPTH
Carter 1	(Oil at 1029' (questionable)	
	(Water at 1042	
	(Water at 1102	
Clara Wilson 3	(Soft white sand at	1008
	(Soft sand at	1110
Clara Wilson 1	Hard and soft sand	972 to 990'
Chicken Roost	Gray sand at	1013
Comanche Park Well	Water sand at	994
Enloe 1	Dead oil sand at	1151
Enloe 2	Water sand	1151 to 1195'

* All figures given as overlying the Wilson formation are measured from top of Wilson formation to top of sand in question.

** See composite log, Plate I.

Hence, future drilling should take into consideration the probability of a water zone between 315 and 315 feet above the Wilson formation.

THE BOTTOM WATER SAND

The bottom water sand is taken to mean the water sand immediately underlying the Wilson formation. Of course, if a deeper productive zone is developed, this sand can no longer be termed the bottom water sand. Although "bottom water" is a term neither rigid nor descriptive, its use has grown with oil-field practice, and is continued here.

As the Wilson formation proved to be comprised of lenticular oil sands, the bottom water zone was not a continuous and regular sand. See section of logs, Plate II. Wells struck this lower sand as follows:

WELL	SAND	DEPTH BELOW TOP OF WILSON FORMATION.
Patsy Oil Co. Sec. 12	Hard pack sand (?)	75 feet
Carter 2	Broken lime	100 "
John Wilson 3	Hard sandy lime	90 "
Frank Perry 1	Gray sand	95 "
Bristow 1	No sand found at depth drilled	72 "
Clara Wilson 2	(Sandy lime	90 "
	(Salt water sand	118 "
Clara Wilson 3*	Salt water sand	90 "
Clara Wilson 4	Sand, shows oil	80 "
Comanche Park	Loose sand, dead	70 "
Susan Perry 1	Sand (?)	65 "
Weldon 1*	Salt water sand	105 "

These figures then indicate that the bottom water occurs in a zone and may be expected anywhere below a depth of, say, 80 feet below the top of the Wilson formation. It will, no doubt, be found in any formation loose enough to carry it, but so far has not been found less than 80 feet below the top of the Wilson formation.

*See Water Analyses, page 28.

This sand carries much salt water sand and the water when tapped will raise two or three hundred feet in the hole. Analyses of this water made by Mr. D. B. Dow, of the Bureau of Mines, are given on pages 28 and 29 of this report.

OTHER DEEP WATER SANDS

A salt-water sand was found in Clara Wilson 4 at 1485 feet (190 feet below top of Wilson formation) and in Enloe 1 there was a salt water about 155 feet below the top of the Wilson. Inasmuch as the formation overlying this sand in Clara Wilson 4 is sand, shell and quartz gravel it seems probable that this is the same formation as that in Enloe 1.

The oil and water sand at 1559 feet in Susan Perry 1, the tar sand at 1545 feet in the Comanche Park Well, the water sand at 1549 feet in Clara Wilson 4, and the sand (contents not determined) at 1667 feet in Frank Perry 1, all correlate nicely. This water sand, which seems continuous, occurs 250 feet below the top of the Wilson formation. Because of the use of rotary tools no samples from these deep water sands have ever been obtained.

DEEP OIL SANDS

The 1800-foot Sand.

From present indications the 1800-foot sand at Comanche is the most promising of all. It has been encountered in the following wells:

Wells:	Depth	Thickness	Productivity
Frank Perry 1	1932 to 1952 feet	20	not tested
Clara Wilson 4	1765 " 1824 "	59	not tested
John Wilson 3	1799 " 1809 "	not thru sand	15 barrels per day
Carter 2	1800 " 1804 "	(?)	no test-- top of sand probably passed with rotary tools
Dirks 1	2020 "	(?)	75 barrels per day
Enloe 1	1921 " 1937 "	(?)	tested salt water

The 2260-foot Sand.

When the Frank Perry hole was lost by junking in April, 1919, the oil sand from 2254 to 2265 feet was supposed to be the most encouraging feature that the field had developed. Clara Wilson 4 was drilled on the strength of this discovery, but at

the proper stratigraphic level failed to show any oil sand. A light brown sand was discovered at 2133 feet, however, which was logged as a water sand by the rotary driller without an actual test being made. The following tabulation gives the known data on this sand:

Well	Sand	Depth, feet.	Depth below Wilson formation; feet.	Thickness, feet.
Frank Perry	Rich oil sand	2254	843	11 (not through)
Clara Wilson 4	Light brown sand; may carry water	2133	843	53
Comanche Park	Gray sand, tested water	2132	842	38

DRILLING CONDITIONS

General Statement.

For the most part, the upper part of a hole is "easy digging" with either standard or rotary tools, but at 2000 feet certain limes are so hard that a rotary bit will not make more than 6 or 8 inches of hole before losing its edge and gage.

Rotary rigs are without a doubt, the most feasible and economical means of making hole in such a cavey area as this. The Red Beds consist primarily of red shale, with an occasional blue shale lens and a few scattered sands here and there. Unless a hole is being drilled in hard sand or lime it tends to cave badly. This necessitates the use of a number of strings of casing with standard tools as the pipe soon becomes loggy. The only example of standard-tool drilling is Carter 1 and the casing record is given here to show the depth each string of casing was carried.

Size of Pipe. inches		Depth landed. feet
20	Conductor pipe	47
13 1/4	Casing	543
10	Casing	947
8 1/4	Casing	1336
6 5/8	Casing	1376
	(No casing pulled)	

COMPARISON OF STANDARD AND ROTARY TOOLS

Drilling in Southern Oklahoma.

Both rotary and cable tools have advantages and disadvantages for drilling in southern Oklahoma.

For drilling hard formations that stand up well in the hole and allow casing to be moved or pulled practically at will, undoubtedly cable tools are more satisfactory. They can penetrate hard formations that a rotary bit can only scratch, show with greater certainty the nature of formation penetrated, and above all make it possible to identify every show of gas, water or oil no matter how small, if drilling with a "dry hole." The accurate information gained from a standard tool hole is invaluable, hence standard tools are a great favorite in "wild cat" work.

Standard tool drilling should not end when the first wild cat well has become an oil well for the exact location of the sands in other parts of the field cannot be determined from the log of one hole. All pioneer work should be carried out with cable tools to insure that the information which an operator needs and deserves is dependable.

When the sands have been definitely determined, however, one soon finds that rotary tools used in combination with standard tools overshadow cable tools in carrying on the drilling campaign. For drilling the upper formations of the hole, rotary tools will have the advantage of lower cost, protection of certain upper gas and oil sands without the use of extra casing, no reduction in size of hole, and greater speed of drilling. For comparison, the following approximate figures are quoted for cost of well drilling in southern Oklahoma by (1) cable tools and (2) rotary tools:

(1) Standard Tools.*

(a)	96-ft. rig - no machinery - approx.				$3500.00
(b)	Drilling contract - 1381 ft. at $5 per ft . . .				6905.00
(c)	Fuel - 90 days at $12 per day				1080.00
(d)	Casing				
	20" - 90# -	47ft.	@ 7.10	$ 33.37	
	13 1/2" - 42# -	543ft.	@ 2.91	1570.13	
	10" - 35# -	947ft.	@ 2.04	1931.88	
**	8 1/4" - 24# -	1336ft.	@ 1.40	-------	
	6 5/8" - 24# -	1374ft.	@ 1.36	1868.64	
					5404.02
(e)	Swabbing and bailing				480.00
	Total cost with standard tools				$17369.02

*All price quotations are for August, 1919.

**To give due credit to standard tool method the 8 1/4 casing at 1336 feet was omitted from the cost statement.

(2) Rotary Tools.

(a) 96 ft. rig - no machinery		$ 750.00
(b) Drilling contract - 1381 ft @ $5 per ft.		6905.00
(c) Fuel - 15 days at $15 per day		225.00
(d) Casing		
10" - 35# - 47 ft. @ 2.04	$ 85.88	
6 5/8"- 24# 1374 ft. @ 1.36	1868.64	
		1954.52
(e) Swabbing and bailing		480.00
Total cost with rotary tools		$10314.52

Total Cost per foot.

(1) With standard tools	$12.58
(2) With rotary tools	7.47

These figures illustrate the comparative costs of two wells and approximate the average costs for wells drilled by the two methods. Evidently standard-tool drilling costs more than rotary-tool drilling, also a rotary rig may be preferred because of speed. If the lease holder using standard tools decides to sink a well which may require an offset, surely he would not like to have the operator of an adjoining property sink an offset with rotary tools in, say, three weeks and drain the territory for three or four months before his offset could be completed. Again an operator must have considerable capital tied up in tools, casing, leases, etc. and meet the constant overhead expense of superintendency, etc. Hence he drills his property rapidly in order to realize a return on his investment as soon as possible Rapid drilling not only protects against offsets on adjoining properties, but cuts down the time that must elapse before a property is on a paying basis.

Some disadvantages of rotary drilling, even for wells in proven territory are as follows: (1) Inaccurate well logs, because of the drillers' inability to detect a change or to determine the character of the formation being penetrated; (2) impossibility of detecting a water sand without a test; (3) possibility of passing a gas sand; (4) possibility of passing an oil sand; (5) danger of mudding off an oil or gas sand without realizing it; (6) inability to drill hard formations.

There is always the possibility of mudding in a gas or oil sand, particularly where the rock pressure is not very high. In the Walters field a 46,000,000 cubic foot gas-sand was passed without being discovered. As a column of mud fluid 1000 feet high may exert a pressure of 477 pounds per square inch, it is not surprising that a gas sand with 300 or 400 pounds rock pressure fails to blow out of a hole 1300 feet deep.

A sand may become permanently mudded unless it is "live" with sufficient gas pressure to clear itself when the column of fluid is reduced.

Method of Making a Good Rotary Log.

The rotary log may be kept with considerable accuracy when the drill is nearing a known oil or gas bearing formation. At such times the driller drills ahead for two feet, then circulates mud fluid for, 20 minutes or half an hour, the interval depending on the depth and speed of pump. The casing head is provided with a split collar which causes the stream of mud fluid to flow in one direction towards the sump. A bucket placed under this stream of mud catches the heavier particles or cuttings as they are carried in the mud fluid from the hole. By diluting the mud in the bucket with clear water several times, the drill cuttings will alone remain and can be examined. Great care must be taken in examining the cuttings as the majority of the chunks washed up will be pieces of red and blue shale even though drilling in sand. If these cuttings show no small bits of sand, the driller, bearing in mind the action of his "chain" and drill pipe and the extent to which his bit is scoured, will probably log red or blue shale, hard, soft or sandy as the cuttings may indicate.

If sand is encountered, the driller, if drilling carefully, will suspect it. By examining the bit he will find it scoured and out of gage. Sand particles will probably appear in the cuttings after washing out and these pieces will vary from the size of the lead of a pencil to chunks 3/16 inch in diameter. Some pieces of free sand will always be found. Unless casing is set before the hole is drilled into the sand, only a few pieces of sand will be found in a hand full of cuttings. These may have fallen from some sand above or may be from the formation just penetrated, so the driller's knowledge of the way his drill has been running and the appearance of the bit must finally decide the case.

It is very hard to keep an accurate log of the formations at 2000 feet at Comanche, as those formations are mostly sands or limes and pieces of sand from the upper formations are constantly knocked off by the drill pipe. Thus if a sand is penetrated and is detected with some certainty by the action of the drill pipe, etc. the driller may "wash out" thoroughly and then find both gray and brown sand in the cuttings. In order to determine what he should log the driller should recall the way the formation drilled, whether easy or hard, where the last gray or brown sand was passed, and then examine the sand to identify it if possible with one already passed. If operators

would instruct their engineer or geologist to remain on the derrick floor for the purpose of collecting samples of the formation, particularly when the drill is nearing a key bed or a producing sand, the hazards of rotary drilling would be greatly diminished.

Another safeguard against passing a formation has been employed with success by the Comanche Petroleum Co. This consists in having the day driller make new hole with a small bit, watching all formations carefully. The night driller then reams the hole and also watches the formations carefully, thus providing a check of the work.

Use of Core Drills.

To date no use has been made of core drills in the Comanche field. Core drills have been used in certain fields of Texas with considerable success. The core drill is a device that can be substituted for the fish-tail bit and is valuable to use when drilling ahead to "feel" for the sand. At Comanche, for instance, it would be well worth while to take core samples from a point 75 or 100 feet. above where the sand is expected until the sand is encountered. Samples of stray sands encountered with the rotary could also be obtained with such a drill without appreciable loss of time or trouble.

Suitable Development Methods for Comanche Field.

In summarizing the most suitable development methods for a Red Bed area, the following points seem appropriate:

1. Sink enough holes with standard tools to accurately locate all formations and in particular water, oil, and gas sands.

2. Collect core samples, water, oil, and gas samples and water level data from each productive strata for use in connection with future development.

3. Then conduct a rotary drilling campaign with all possible speed, slowing up only to locate certain well-defined markers and when within, say, one hundred feet of the expected productive sand.

4. Proceed slowly with rotary when nearing sand, washing out every two feet for a sufficient length of time to absolutely insure "returns" in the cuttings, or better still, install cable tools. If it is planned to complete the well with rotary tools, immediately substitute clear water for mud fluid once the productive sand is encountered and circulate for some time to wash the sand clean of mud which may have penetrated it.

5. If a sand found near the known productive zone fails to show oil, casing should be set and the sand tested for gas or water.

6. As soon as the productive sand is determined, land pipe on the nearest suitable formation above and prepare to complete hole.

7. After casing is landed, the hole should be bailed dry and allowed to stand for 12 hours, then bailed again. If still dry, or only a barrel or so of water is found the job may be considered as good.

8. If cement is used, the hole should stand undisturbed for two weeks; then it should be bailed dry or to a safe depth (to prevent collapse of casing.) After standing 12 hours, the bailer should be run again or the fluid level again taken to determine if the casing is leaking. Drill out the cement plug and allow the hole to stand 12 hours more before the bailer is run again to determine if water has come in. If the string is dry this time the well can be completed with certainty that the shut-off of upper waters is successful. A cemented hole can be completed more easily with a portable drilling machine. The usual drilling methods are followed after proper casing-head fitting and anchors have been provided. Thus, the rotary tools can be moved while the cement is setting and can be kept working to capacity.

9. If well is to be completed with rotary, make a formation shut-off* and after the bailing test pump all mud from pit and substitute clear water for drilling in.

10. Drill in slowly, 2 feet at a time and wash out returns. If sand is broken with shell or shale, test each sand as encountered in order to determine which carries gas, oil or water. Do not drill deeper than 55 feet below the top of the Wilson formation* and in no case as deep as 85 feet below the top of the Wilson formation as bottom water may occur at this depth.

11. A proper test for any sand consists of bailing the hole dry or to such depth that the gas blows out. It is not fair to condemn a sand until the hole is thoroughly washed with clear water and bailed in order to give the sand a chance to produce.

*See page 21 The Formation Shutoff.
*See discussion, Page 21 The topmost producing sand is not necessarily the top of the Wilson formation. See also page 13 Depth to Bottom Water.

PROPER CASING DEPTHS.

In the Comanche field, however, the oil sands are so irregular that one can never be sure whether the drill has nearly reached the producing sand, so either of two methods of procedure must be followed.

(1) Land the pipe well above the sand and prepare to set a liner in the open hole between the casing shoe and oil sand, or

(2) Drill ahead with a small bit and "feel" for the sand, setting the casing on the nearest hard stratum above the sand or in gumbo or shale after the sand has been discovered.

Although all operators extremely dislike to use liners, some have decided that they would rather set a liner than risk the rotary too near the sand. More certainty of water shut-off is obtained by this method, as a suitable formation for seating the casing may be chosen at any point above the sand.

On the other hand, if the operator drills ahead with a small bit or uses a core drill when nearing the sand to safeguard himself in obtaining a good casing later, and if he tests the first sand near the depth shown by the contour map for the Wilson formation, it is believed that the producing sand will be determined more readily and a minimum amount of open hole left between casing shoe and oil sand. Attention is again called to the necessity for testing a sand by setting a string of casing above it and bailing the hole. The method outlined allows some elasticity in casing depths and also insures a thorough test by bailing for every sand in the producing formation.

METHOD OF SHUTTING OFF WATER AT COMANCHE

The two usual methods, the formation shut-off and the cement shut-off, have been used at Comanche for shutting off water.

The Formation Shut-Off.*

To make the ideal formation shut-off, it is desirable to find a hard lime shell a short distance above the oil sand in order (1) to provide a good impervious casing seat and (2) to finish the well with the smallest possible amount of open hole.

*Tough, F. B. - Remarks on the Formation Shut-off - U. S. Bureau of Mines Bulletin No. 163 - pp. 16 and 17.

A hard shell for a casing seat is not absolutely necessary, however, and will seldom be found at the right place, but a good shut-off can be made in shale or gumbo if ordinary care is used. Different ways of making the formation shut-off are briefly described below.

With Diamond Point Bit. - Rotary Tools

By drilling about one foot into a hard lime with a diamond point bit, a shut-off can be effected by seating the casing, fitted with a strong and especially designed shoe, into this tapered hole. The great drawback of this method is the small area of contact between the casing shoe and the lime. A small water ccurse would soon develop into a very substantial leak past the shoe.

Seating the Casing in Small Hole - Rotary and Cable Tools.

By drilling about 10 feet of small hole ahead of the casing and dropping the pipe with a strong shoe into this hole, a good shut-off can be made. The size of the small hole depends on the formation in which the string is to be landed. For 6 5/8 inch casing, for instance, the hole should be reduced as follows:

External diameter of 6 5/8 inch casing (all weights)	7 inches
Size hole carried with rotary for 6 5/8 inch casing	9 7/8 "
If in shale or gumbo reduce hole to about	6 1/2 "
If in lime reduce hole to	7 "

The casing must fit tightly against the formation.

Formation shut-off with use of a packer - Rotary or Cable tools.

J. C. Crump, of the Fort Ring Oil Co., recommends the use of a "poor man's" packer in conjunction with the formation shut-off. This packer need only be a small home-made affair of canvas wrapped on the pipe. Often two are used, say 8 feet apart. The small hole is drilled, but not so tight as to make the seating of the casing difficult. Cavings fall in between and on the top of these packers and eventually pack solidly around the shoe joint. Care should be taken not to drop the casing from any height for fear of damaging the shoe, buckling a coupling, or in other ways injuring the string so that it will leak. Driving the pipe into place is also recognized as dangerous practice.

Shut-Offs with the Use of Cement.

The value of cement in shutting off upper water has been proven in the Comanche field and the writer heartily recommends its use. However, in cementing a well one must know the formations otherwise the casing may be set too low and shut off a good oil sand. It is therefore necessary that when a well is

to be cemented, the sand be drilled into carefully and an accurate log obtained.

BEST CEMENTING PRACTICE

The various methods of placing cement behind water strings are covered quite thoroughly by F. B. Tough in Bureau of Mines Bulletin 163.* If the operator desires to use any one of the methods outlined below and is not familiar with all mechanical details, he should refer to Bulletin 163. However, a brief description of certain methods considered suitable for the Comanche area will be given in order to enable operators to chose the method most feasible for their particular wells.

The Perkins Process, or Two-Plug Method, is much used in rotary holes, and should prove successful at Comanche, 25 or 30 sacks of cement being enough. The cement is mixed as thick as a pump can handle it and is pumped into the casing with a plug ahead and behind the cement to prevent the latter mingling with the mud fluid.

The casing is lifted about one foot off the bottom and water is pumped in to drive the plugs down. When the pump stalls the plugs have hit the bottom. They are so necked that the upper part of the bottom one stands in the casing to provide a seat for the top plug, yet it allows the cement to escape from the casing. By metering the water which is pumped in, an absolute check is made on the depth of the plug, thus preventing it from stopping high in the casing. The good circulation necessary for the success of this method is usually obtainable in a rotary hole.*

The One-Plug Method.

Most of the cementing jobs at Comanche have been done by using two plugs, but the job described here was done with only one plug and that on top of the cement. Numerous jobs have proved the method successful.

Description of Cementing Job, Carter 3, Comanche, Oklahoma.

1. Had circulation with rotary mud	12:00 m.
2. Bailed hole down 200 feet (casing on bottom)	2:00 p.m.
3. Started mixing 25 sacks cement	2:30 p.m.

*Tough, F. B. - Methods of Shutting Off Water in Oil or Gas Wells - Bulletin No. 163 - U. S. Bureau of Mines.

4. Hole standing with 1100 feet of rotary mud inside casing 2:30 p.m.
5. Began pouring cement into casing 3:15 p.m.
6. Finished pouring. 3:47 p.m.
7. Put in wood plug, put on circulator head and lifted pipe 14 inches off bottom 4:00 p.m.
8. Circulating pump started 4:05 p.m.
9. Plug hit bottom and stalled pump 4:14 p.m.
10. Casing lowered to bottom and pump started, stalled again 4:15 p.m.
11. Gate valve closed on pump discharge line and pressure kept on for about 14 hours.
12. Pressure released at end of 14 hours and tools moved. Hole stood 2 weeks before testing.
13. Results of job; water shut out.

The time between the initial wetting of the cement and the final placing was longer in this instance than it should have been.

Although certain modifications would help this method, it is not considered as safe as the two-plug method.

Dump Bailer Method.

This is probably the simplest method of placing a small batch of cement. Fifteen or twenty sacks are mixed in a box on the derrick floor and lowered in a dump bailer.* It will take about 3 runs with a 5 3/4 inch bailer 30 feet long to place 15 sacks. The casing should be pulled up 50 or 60 feet as the cement may stand as high as 50 feet in a hole drilled for 6 5/8 inch pipe. In a larger hole the casing need not be lifted so high. Fill the casing with water, place the cement and see that the casing head is closed, then lower casing to bottom. The water inside the pipe will prevent any cement from entering at the bottom and will cause the cement to rise in the hole outside the casing. This method is admirably adapted to the Comanche area as it is simple and trustworthy; but the operator is warned that the success of this method depends upon his ability to fill the casing full of water and keep it full while the head is being put on and the string being lowered. If this can not be done, part of the cement will rise inside the casing and endanger the success of the job.

*If a regular dump bailer is not at hand, an ordinary bailer can be converted into a dump by suspending from the bail a chain long enough to play out with the cement and hold the valve off its seat as the bailer is raised. Drillers also make from a piece of steel, a small latch which bolts to the dart and holds the valve open, once the bailer dumps.

The Tubing Methods.

Because the tubing methods involve an unnecessary amount of work and material, and cement can be placed in rotary holes by more simple means, it is not considered advisable to recommend their use in this field.

SHOOTING TO BRING IN PRODUCTION

It is believed that shooting will not materially help a non-productive well in the Wilson formation because the sands are comparatively soft. The softness of the producing sands contrast strongly with the flinty oil sands of the northern part of the state. No set rule should be laid down, however, as the formations at Comanche show a decided tendency to change in character within short distances and one can never tell when a well may strike a hard limy oil sand that would need a shot before it would yield much oil.

ANALYSES.

(a) Oil distillations.

The accompanying distillations made by Mr. Law in the Bureau of Mines laboratory at Bartlesville were of samples obtained from the flow lines of each of the wells.

The radical differences between oil from the Carter wells and that from the other wells of the field is noteworthy. This is a further evidence that the Carter wells produce from a different sand.

DISTILLATIONS - COMANCHE CRUDE

Well : Product...End Point	Gasoline 350° F	Kerosene 450° F	Mineral Seal 590° F	Residuum	Crude Be' gravity at 60° F
T. A. Edmonds	30%	12%	18%	40%	39.6
Carter 1	27	11	19	43	38.0
Carter 3	26	10	23	41	36.2
Clara Wilson 1	17	12	27	44	33.6
J. Wilson 2	17	12	22	49	33.5
Isaac 1	17	16	22	45	33.7
Susan Perry 1*	0	12	28	60	27.5

*Sample from tank - Cravity compares favorably with field test as oil is too heavy to weather much.

(b) Gas Analysis

Below appear analyses of gases from both the shallow sand and the Wilson sand. Mr. R. O. Neal and Mr. D. B. Dow of the Petroleum Experiment Station, Bartlesville, kindly made these analyses.

Well number	Initial rock pressure lbs. per sq. inch.	Production Initial open flow-million feet.	Calorific value B.t.u.	Per cent methane (CH_4)	Per cent ethane (C_2H_6)	Per cent carbon (CO_2)	Per cent oxygen (O_2)	Per cent Nitrogen (N)
(Shallow Wells)								
L. Johnson 1	320	4	974	67.19	18.75	0.52	0.00	13.54
Carter 1 1/2	310	2 1/2	995	69.16	18.88	0.38	0.28	11.31
Bristow 2	No sample obtainable; casing-head fittings wrecked by lightning.							
(Deep Wells)								
John Wilson 1	480	16	907	66.97	14.94	0.38	0.25	17.45
John Wilson 2	350	12	970	58.52	23.38	0.51	0.51	19.96
Clara Wilson 1	500	20	966	59.52	22.62	0.25	0.51	17.09

All samples taken by water displacement method.

(c) Water Analyses.

As the writer was not in the field when Carter 1 was drilled, he could obtain no water samples from the upper sands. Below are the analyses of samples of bottom water taken at the depths of 1384 feet in Clara Wilson 3 and 1422 feet in Weldon 1.

A knowledge of the individual characteristics of every water in a field is extremely valuable. No matter what caution may be exercised in development, sooner or later one or more producing wells will start to make water. Before attempting to repair a wet well the source of the water must, of course, be known. One of the most dependable ways of learning just what sand the water comes from is by comparing a chemical analysis of the water with analyses of waters from known horizons. Although upper waters may show considerable similarity, in every field there has always been a marked difference between the upper waters and the edge waters in the producing sand, or between upper waters and bottom waters (in strata below the producing sand). This fact is important for the operator does not particularly care which of the upper water sands furnishes the water, but he does want to know whether the water string is leaking, whether the water is in the oil sand, or whether the well is drilled too deep. The form of presenting the chemical analyses for comparison must be chosen after enough water samples from different levels have been taken to permit accuracy and thoroughness in the study. For instance, Dr. Chase Palmer in U.S.Geological Survey Bulletin 479 has based his study of waters principally upon alkalinity and salinity. Mr. R. O. Neal's paper in Bulletin No. 145 of the American Institute of Mining Engineers, while giving due weight to alkalinity and salinity, calls attention to the great difference between the "total solids" of bottom and of top waters.

Other ways of expressing the analysis are in the terms of oxides, hypothetical compounds, and probably most important of all, the percentage method.* Each of these methods has certain advantages, but A. W. Ambrose** of the Bureau of Mines, in his study of California waters, found that the percentage method was most direct and least misleading.

The analyses were made by D. B. Dow and M. S. Law of the Bartlesville station.

*Stabler, H., U.S.G.S., Water Supply Paper 274; Palmer, Chase, U.S.G.S., Bulletin No. 479.

**Ambrose, A.W., U. S. Bureau of Mines, Bulletin soon to be issued.

ANALYSIS OF WATER FROM CLARA WILSON 3.

Section 20, T2S, R7W, Sand 1384 Feet.
Presented by the percentage method.

Note:- Al_2O_3 - 170.23 gr. per gallon (probably colloidal)

Ca	Mg	Na	HCO_3	SO_4	Cl
223.93	16.47	2556.71	3.74	5.28	4370.87 grains per gal.
(x0.04994)	(x0.0821)	(x0.0434)	(x0.0164)	(x0.0208)	(x0.0282)
11.16	1.35	110.95	0.06	0.11	123.26
	123.47	plus		123.43	= 246.90

Percentages

Ca	Mg	Na	HCO_3	SO_4	Cl
4.52	0.55	44.94	0.025	0.045	49.92
				Total	100%

Strong acids	49.965	Primary salinity	89.88%
" bases	44.94	Secondary salinity	10.05%
Strong excess acids,	5.025	Secondary Alkalinity	0.09%
Weak bases	5.07	Total	100.02%
Excess weak bases	.045		

ANALYSIS OF WATER FROM WELDON 1.
Section 20, T2S, R7W. - Sand 1420 Feet.

Ca	Mg	Na	HCO_3	SO_4	Cl
156.547	168.726	2232.402	5.366	--	4200.263
(x0.0494)	(x0.0821)	(x0.0434)	(x0.0164)	(x0.0208)	(x0.0282)
7.733	13.852	96.886	0.088	--	118.446
	118.50	plus		118.51	= 237.01

Percentages

Ca	Mg	Na	HCO_3	SO_4	Cl
3.26	5.84	40.88	0.05	0.0	49.97
				Total	100%

Strong acids	49.97	Primary salinity	81.76%
Strong bases	40.88	Secondary salinity	18.18
Excess strong acids	9.09	" alkalinity	0.02
Weak bases	9.10		99.96%
	0.01		

Comparison of Analyses

		Ca	Mg	Na	HCO_3	SO_4	Cl
Clara Wilson 3	%	4.52	0.55	44.94	0.025	0.045	49.92
Weldon 1	%	3.26	5.84	40.88	0.05	0.00	49.97

Total solids:

Clara Wilson 3 - 67,900 grains per gallon.
Weldon 1 - 73,480 grains per gallon.

The comparison of these waters does not have as much meaning as it would if a third water sample, from an upper sand has been analyzed. However, experience has proved that waters from different zones, particularly from one zone above and the other below the oil sand show more marked differences than can be found here. It is believed that the waters shown above are from the same stratum.

Method of Taking a Water Sample

A water sample is of no value unless undiluted and from a known horizon. The best method of obtaining water samples is from the bailer of a cable-tool drilling well when a new stratum is penetrated.

Water samples from one well are not enough for properly determining the characteristics of the various waters in the entire field. As many samples as possible should be obtained, for the value of the results depends primarily on the extent of the data.

A water sample taken from a drilling well before the drilling water is bailed out is valueless. When the driller reports having struck a water sand, the procedure for obtaining a dependable sample is as follows:

1. Make sure that the last water stratum above has been cased off and is not furnishing the water.

2. Run bailer 5 or 6 times to rid hole of drilling water and mud.

3. When water is bailed up practically clear, have driller dump bailer over a bucket.

4. Take duplicate samples to provide against breakage and loss. Two-quart fruit jars are excellent containers.

5. Label the samples and send them to the chemist, or store them until water troubles justify thorough study.

Water samples should be taken early in the development of the field, for sooner or later water from different zones will intermingle, and analyses of such mixtures of waters will be of no value, unless the analysis of individual waters had previously been determined.

NEED FOR COOPERATIVE WORK BETWEEN THE ENGINEER AND DRILLER

To enable the engineer and the driller to work together most advantageously, and each benefit from the other's particular knowledge, it is necessary to establish a mutual appreciation for each other's line of work. While the driller should be cautioned as to the necessity for keeping an accurate and descriptive record of his work to aid the engineer, the engineer on the other hand, should gather the information of the practical man until every phase of that work is familiar to him. In this way the two will eventually meet on a common footing, each understanding the needs of the other.

To educate the driller in identifying formations is of the utmost value.* The driller will rarely give the formations the attention that is desired, and he cannot be expected to become a mineralogist. He should, however, be expected to learn to identify the three main classes of formations encountered in the Mid-Continent fields, namely sandstones, limestones, and clays or shales. If drillers could always distinguish these three formations with certainty and add to their description the simple colors, such as red, blue, grey, black, white, and also whether hard, soft or sticky, the work of the subsurface man would be greatly simplified. The standard tool drillers seem to keep a more careful log than the rotary tool drillers. The latter do not have as favorable opportunities for keeping the log, and many have been in the oil business so short a time that they have not realized the need of keeping a complete and accurate record of their operations. The writer has found practically every driller whom he has met in southern Oklahoma both ready and eager to locate key beds or markers. This in itself is a very great aid. But if the driller is to learn how to identify and properly record the formations, ought not the engineer to learn exactly what a driller means when he logs "red beds," "sandy lime rock" or "broken shale?" Surely it is easier for an engineer to learn the driller's terms than to teach all the drillers in a field the engineer's terms. The writer found that by learning from the drillers the exact meanings of the terms they used in keeping their logs he could make a much more intelligent correlation of the different logs.

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*Udden, J. A.- Aids to Identification of Geological Formations, Handbook Series, Bureau of Economic Geology, Univ.Texas,Austin,Tex.

What one driller calls a "sandy shale" another may log as "sand and shale" or even "broken shale."

Both standard and rotary drillers observe the action of their tools closely, the speed with which hole is made, the shape and marks on the bit when withdrawn from the hole, the mud on the bit and the cuttings bailed or washed from the hole. The cuttings are, of course, subjected to the ready tests of the eye (color, shape and texture) weight, touch, (whether hard, soft, gritty or gummy) and taste. A driller, provided with a vial of chloroform, might make the usual test for oil sand but this is rarely done.

The engineer will seldom find a more baffling problem than that of rotary logs and to enable himself to interpret them intelligently he should strive to become familiar with the terms his drillers use. Often a driller logs a certain formation quite different from his tour mate; a knowledge of this fact is naturally of the utmost value.

CONCLUSIONS

This report is in fact a progress report and illustrates the manner in which the engineer may apply principles to the development of a new oil field.

The preparation of giaphic logs, stratigraphic contour maps, engineer's sections, etc., was the first step taken in working up this new field, for these data enable the engineer to understand underground conditions. The contour map should now serve as a guide in future drilling, both as to location of new wells and the probable depths of the sands.

The probable depths and contents of the various sands were determined by a correlation of all the known data and should aid future development methods.

The writer believes that where possible the first few wells in any new field should be drilled with cable tools. However, after the structure and sands have been roughly determined, combination rotary and standard tools are ideally suited for carrying out subsequent development. The need for frequent and thorough tests for sands when drilling with rotary tools is again emphasized.

While formation shut-offs have served well in southern Oklahoma, the Bureau of Mines strongly favors the use of cement in shutting out water. A more certain and lasting job is thus obtained.

Although the production of the Comanche field is still small, it seems advisable to recommend the taking of water samples in order to solve future water troubles. The value of water analysis in oil field work has been thoroughly proven in other territories.

APPENDIX

Approximate Locations of Comanche Wells, and elevations.

Scaled from Maps of 1-inch to 1000 feet - Subject to errors in keeping with that scale.

	Lat.	Dep.	From Corner of Section	T-R	True elevation. Derrick floor.
Lone Star Well	200 N	500 W	SE Sec 5	2-7	1138.5
Magnolia Dobbs 1	630 S	150 W	NE " 7	"	998.5
Edmonds	2300 S	2440 E	NW " 12	2-8	1104.
Patsy Oil Co., Frances Fobb 1.	930 N	1130 W	SE " 12	"	1061.
Dirks-Kisson Battiest.	258 S	2390 E	NW " 13	"	1104.5
Frank Perry 1	2840 S	1120 W	NE " 18	2-7	1034.
Magnolia Carter 3.	1280 N	200 E	SW " 17	"	1000.5
" " 1.	910 N	200 E	SW " 17	"	1006.
" " 2.	910 N	680 E	SW " 17	"	999.
" " 1⅓.	910 N	250 E	SW " 17	"	1005.
Clara Wilson 2.	480 N	200 E	SW " 17	"	999.
Comanche-Bristow 1.	910 N	200 W	SE " 18	"	1009.
Exchequer - Bristow 1.	200 N	1520 W	SE " 18	"	1023.
John Wilson 2	200 S	1520 W	NE " 19	"	1021.5
Clara Wilson 4	600 S	150 W	NE " 19	"	983.
" " 1	600 S	150 E	NW " 20	"	978.
" " 3	150 S	200 E	NW " 20	"	980.
Park Well	1660 S	1820 E	NW " 20	"	979.
Weldon 1	2880 S	990 E	NW " 20	"	983.
Susan Perry 1	1960 N	1960 W	SE " 20	"	1007.
Leo-Lena Johnson 1	900 S	1770 W	NE " 29	"	986.
Enloe 2	150 S	480 W	NE " 30	"	995.
" 3	680 S	280 W	NE " 30	"	973.
" 1	2100 S	580 W	NE " 30	"	970.
Leo-Lena Johnson 2	250 S	2300 W	NE " 32	"	955.Estimated
Keoghan & Hurst-Colbert	950 S	150 W	NE " 25	"	1019.5
Osage Oil & Gas	1450 S	150 W	NE " 24	"	1040.
Alice Isaac	600 S	1950 E	NW " 19	"	1018.
John Wilson 1	1050 S	2450 W	NE " 19	"	1000.
Comanche Isaac 2 Location	1160 S	1800 E	NW " 19	"	1006.5
Magnolia Brown 1	1460 S	1800 E	NW " 19	"	1003.5
Comanche Isaac 3 Location	1460 S	2100 E	NW " 19	"	1006.5
Bristow 2	950 N	200 W	SE " 18	"	1009.
John Wilson 3	700 S	1520 W	NE " 19	"	1020.

Individual Well Histories

W. T. Amos Well, Section 30, T2S, R7W.

No reliable data available. Dry hole.

Comanche Petroleum Co., Clara Wilson 1, Sec. 20, T2S, R7W.

Completed August 1918 - Rotary tools.
Casing 6-5/8 - Approximately 1286 feet - Formation shutoff.
Pay Sand, 1286 to 1324 feet.

Depth 1327 feet
Initial production, 20 million cubic feet dry gas.
Rock pressure approximately 500 lbs.
In spring of 1919 well began to show oil. If properly tubed would probably make 20 barrels per day.

Comanche Petroleum Co., Enloe 1, Sec. 30, T2S, R7W.

Completed Dec. 6, 1918 - Rotary tools.
Sand Record:

Sand showed water and gas	475-520 feet
Sand, sandy lime and quartz gravel tested salt water	1151-1195 "
Sand tested salt water	1431-1480 "
Sand tested salt water	1596-1616 "
Sand tested salt water	1921-1937 "
Depth	1937 "

Plugged with mud fluid - abandoned - casing pulled.

Comanche Petroleum Company, Alice Isaac 1, Sec. 19, T2S, R7W.

Completed Dec. 28, 1918 - Rotary tools.
Casing 8¼" - landed at 1382 feet - Formation shutoff.
Sand Record:

Broken sand - showed oil	1383-1394 feet
Oil sand	1394-1405 "
Deepened 14 feet Sept. 1919 - cable tools - Blue shale from	1405-1419 "

Initial production 30 b/d oil.

Note: - This well made oil for about two months, being pumped. Suddenly it turned to a gas producer for two days, then went back to making oil. It has been flowing at the rate of 15 barrels since.

Comanche Petroleum Co., John Wilson 1, Sec. 19, T2S, R7W.

Completed spring 1919 - Rotary tools.
Casing 6-5/8" - 1359 feet - Formation shut-off.
Sand Record:

Sandy shale (probably 850-foot gas sand)	868-875 feet
Pay sand (gas)	1367-1409 "
Total depth	1409 "

Initial production, 16 million cu. ft. per day gas.
Rock pressure 480 lbs.
October 1919 - Well went to oil - 60 b/d oil - about 15 b/d water.
Now being repaired.

Comanche Petroleum Co., Frank Perry 1, Sec. 18, T2S, R7W.

Completed April 1919 - Rotary tools.
Casing 6-5/8" - 1930 feet - Formation shut-off.
Sand Record:

Broken sand (Wilson)	1433-1445 feet
Sand and shells	1460-1480 "
Blue sand (probably "bottom water")	1509-1532 "
(Sand) Probably all mem-	1860-1880 "
(Sand and shells) bers of 1800-foot	1907-1916 "
(Sand - asphaltum) oil sand.	1929-1952 "
Sand showed oil	2254-2264 "
Total depth	2264 "

Lost tools while preparing for test on deep sand - abandoned.

Comanche Petroleum Co., Susan Perry No. 1, Sec. 20, T2S, R7W.

Completed March 1, 1919 - Rotary tools.
Casing 6-5/8" - landed at 1559 feet - Formation shut-off.
Sand Record:

Sand showed oil (no test)	1097-1115 feet
Sand (Wilson?) (no test)	1308-1337 "
Sand carried oil and water	1559-1569 "
Total depth	1569 "

Note: When two feet into the sand at 1559 feet good showing of oil was noticed. Hole deepened to 1569 feet and salt water came in. Inasmuch as the water string had tested dry it seems that the sand carried both oil and water. Consequently the hole was plugged with two wooden plugs from 1569 to 1563 feet. Water still came in, so

plugs were drilled out and hole filled to 1563 feet with a limit plug, set in neat cement and well driven. The top of the present plug is 1563 feet. The well will make about two barrels of oil and fifty barrels of water per 24 hours. The oil is a heavier grade than the oil from the Wilson sand, testing about 28° Be. gravity from the flow line.

Keoughan and Hurst Comanche Park Well, Sec. 20, T2S, R7W.

Completed September 1919 - Rotary tools to 2110 feet - Cable tools to end.
Casing 8¼" - Cemented at 1290 feet
6-5/8" - Landed at 2110 feet.

Sand Record:

Sand salt water (Wilson)	1293-1298 feet
Hard dry tar sand	1545-1555 "
Hard sand, dry	1555-1565 "
Brown sand	2124-2132 "
Gray sand - salt water	2132-2170 "
Total depth about	2500 "

Abandoned - Dry hole.

Magnolia Petroleum Co., Carter 1, Sec. 17, T2S, R7W.

Completed May 1, 1919 - Cable tools.
Casing: 20" - 42 feet - All casing landed in the formation - no cement used.
13¼" - 543 "
10" - 947 "
8¼" - 1336 "
6-5/8" - 1376 "

Sand Record:

Water sand	295-303 feet
Water sand - Show of gas	395-415 "
Water sand	495-505 "
850-foot gas layer	841-851 "
Water sand	898-910 "
Gas sand	948-954 "
Gas sand	963-968 "
Sand showed oil (?)	1029-1042 "
Water sand	1042-1051 "
Water sand	1102-1120 "
Oil sand	1373-1394 "
Original depth	1381 "
Deepened September 1919 - Present depth	1395 "

Initial production - oil 50 b/d - Flowed.
After deepening production rose to 160 b/d flowed.

Magnolia Petroleum Co., Carter 1½, Sec. 17, T2S, R7W.

Completed August 1919 - Cable tools.
Sand Record:
850-foot gas sand 819-829 feet.
Initial production 2½ million cubic feet per day.
Rock pressure - 310 lbs.
Note:- There is some discrepancy in measurement in either this well or Carter 1, as they are of the same elevation and only 50 feet apart, and the gas sand was found some 22 feet higher in Carter 1½ than in Carter 1.

T. A. Edmonds-Fostor Wilson 1, Sec. 12, T2S, R8W.

Completed April 1919 - Rotary tools.
Casing Record:
8¼" - Landed in formation 1540 feet
6-5/8" - liner 1540-1600 feet.
Sand Record:

Pack sand (850-foot sand?)	650-665 feet
Sandy gumbo and lime - slight show gas	1423-1428 "
Hard sand - showed oil	1431-1433 "
Sand - slight show of oil	1486-1500 "
Oil sand (Wilson)	1591-1600 "
Total depth	1600 "

Note: Well was closed in for five months. Pumping test in September showed a production of 4 barrels per day which increased to 8 or 9 barrels per day. Well has never been cleaned. If cleaned and properly tubed would probably make 12 or 15 barrels per day of 40°Be. oil.

Patsy Oil Co., Frances Foob 1, Sec. 12, T2S, R8W.

Completed April 28, 1919 - Rotary tools.
Casing: 8¼" - landed at 1590 feet - Formation Shut-off.
Sand Record:

Hard sand - showed little gas	1550-1557 feet
Hard pack sand (tested?)	1589-1621 "
Total depth	1621 "

No production - Hole standing idle - Rig down.

Pawnee Osage Oil and Gas Co., Barnett 1, Sec. 24, T2S, R8W.

Completed May 20, 1919. - Rotary tools.
Casing: 6-5/8" - landed at 1455 feet - Formation shut-off.
Sand Record:

Sand showed gas		549-555 feet
Sand showed gas		616-620 "
Hard sand (850-foot gas sand?)		952-972 "
Oil sand	Wilson	1492-1498 "
Sand carried oil and water		1533-1544 "

Note: It is thought that this well marks the position of edge water in the Wilson sand as the lower lens of sand appears to be part of the Wilson formation; also the intervening layer having graded into shale. On John Wilson 1 there were two similar pay streaks while the intervening formation was logged "broken formation."

Comanche Petroleum Co., Enloe 2, Sec. 30, T2S, R7W.

Completed May 1919 - Rotary tools.
Hole junked.
Sand Record:

Oil sand - dead	1151-1161 feet
Sand (no test) Wilson	1422-1467 "

Abandoned.

Comanche Petroleum Co., Enloe 3, Sec. 30, T2S, R7W.

Drilling with rotary tools.
Nothing of interest to report up to 2001 feet.

Comanche Petroleum Co., Clara Wilson 2, Sec. 17, T2S, R7W.

Completed June 19, 1919 - Rotary tools.
Casing: 6-5/8" - landed at 1340 feet - Formation shut-off.
Sand Record:

Sand (850-foot gas layer?)	840-850 feet
Sand - Slight show asphaltum	1119-1123 "
Gray sand, soft	1318-1325 "
Sand	1338-1344 "
Sand - show of oil	1353-1358 "
Sand - salt water (bottom water)	1437-1443 "
Total depth	1443 "

Well probably good for 2 or 3 barrels per day. Abandoned.

Comanche Petroleum Co., Bristow 1, Sec. 18, T2S, R7W.

Completed July 1919 - Rotary tools to 1366 feet - Cable tools 1366 to 1405 feet.
Casing: 6-5/8" - 1359 feet - cemented.
Sand record:

Sand (850-foot gas sand)	835-846 feet
Sand - carried some oil	1363-1370 "
Blue shale	1370-1405 "
Total depth	1405 "

Note: Oil stood 100 feet in the hole after well stood over night. From that time on no oil came into the hole. A shot of 20 quarts of nitro-glycerine was therefore set off between 1363 and 1373 feet, but after cleaning out thoroughly no oil came into hole.

Comanche Petroleum Co., Clara Wilson 3, Sec. 20, T2S, R7W.

Completed May 30, 1919 - Rotary tools to 1307 feet - cable tools 1307 to 1388 feet - Rotary tools 1388 to 1598 feet.
Casing; 6-5/8" - 1307 feet - cemented.
Sand Record:

Gray shale and sand	1282-1307 feet
Sand - poor showing of oil	1307-1315 "
Sand and gravel carries salt water (bottom water sand)	1384-1388 "
Total depth	1598 "

Lost tools - Abandoned.

Exchequer Petroleum Co., Bristow 1, Sec. 18, T2S, R7W.

Completed September 1919 - Rotary tools to 1412 feet - Cable tools 1412 feet to end.
Casing: 6-5/8" - 1410 feet - Cemented.
Sand Record:

Sand - gas	842-847 feet
Sand - carried gas	1223-1234 "
Sand - good show gas	1348-1360 "
Sand - showed oil	1410-1412 "
Blue shale	1412-1425 " (approx.)

Note: The Wilson sand at 1348 feet was cased off behind the 6-5/8" casing. The well was abandoned without effort to repair.

Comanche Petroleum Co., Clara Wilson 4, Sec. 19, T2S, R7W.

Deep test - Now drilling.
Casing; 8¼" - 2623 feet - Cemented.
Sand Record:

Shale and boulders (probably Wilson sand)	1284-1313 feet
Oil sand (Wilson sand)	1313-1320 "
Oil sand good (no test)	1377-1405 "
Water sand	1549-1568 "
Hard sandy lime	1751-1765 "
Oil sand	1765-1824 "
Brown sand (probably carries water - no test)	2133-2186 "
Present depth	2625 "

Nothing of interest to date.

Comanche Petroleum Company, John Wilson 2, Sec. 19, T2S, R7W.

Completed July 7, 1919 - Rotary tools.
Casing: 6-5/8" - 1345 feet - Formation shut-off.
Sand record:

Gas sand	853-875 feet
Sand showed some oil	1277-1281 "
Wilson oil sand	1350-1356 "
Blue gumbo	1356-1361 "
Oil sand	1361-1371 "
Deepened 7 feet - oil sand	1371-1378 "
Total depth	1378 "

Initial production - 12 million cu. ft. gas per day.
Rock pressure 310 lbs.
Production after deepening, 8 barrels per day oil - water 0.

Magnolia Petroleum Co., Carter 2, Sec. 17, T2S, R7W.

Drilling:	Rotary tools	0 to 1351 feet
	Cable tools	1351 to 1400 "
	Rotary tools	1400 to 1804 "
	Cable tools	1804 to present depth.

Casing: 6-5/8" - 1351 feet - Cemented.
5-3/16" - 1800 feet - Formation shut-off.
Sand Record:

850-foot gas sand	842-864 feet
Broken sand-poor showings of oil	1365-1377 "
Sandy lime (bottom water strata)	1440-1477 "
1800-foot oil sand	1800-1804 "

Note: Installed Star rig at 1804 feet - Drill penetrated red shale from 1804 to 1820 feet.

Magnolia Petroleum Co., Carter 3, Sec. 17, T2S, R7W.

Completed September 1919 - Rotary tools 0 to 1327 feet
Cable tools 1327 to 1388 "
Casing: 6-5/8" - 1327 feet - Cemented.
Sand Record:

Sand-strong gas showing	842-863 feet
Sand-slight show gas and oil	1240-1251 "
Oil sand	1363-1388 "

Initial production 40 barrels per day oil.

Comanche Petroleum Co., John Wilson 3, Sec. 19, T2S, R7W.

Completed October 1919 - Rotary tools.
Casing: 6-5/8" - 1770 feet - Cemented.
Sand Record:

Gray sand (850-foot gas?)	860-870 feet
Brown and gray sand showed oil	1224-1252 "
Sand - oil showing	1305-1317 "
Red shale and gravel)	1360-1372 "
Sand) Wilson	1399-1403 "
Oil sand) formation	1403-1415 "
Hard sandy lime (bottom water zone?)	1450-1460 "
Sand - show of oil	1776-1786 "
Sand - show of oil and water	1799-1809 "
Present depth	1809 "

Note: Well shot with 20 quarts nitro-glycerine - Pipe bad.
Pumping test showed 15 b/d.- Oil gravity 35° Be.

Herman Dirks - Kisson Battiest 1, Sec. 13, T2S, R7W.

Drilling: Rotary tools 0 to 1317 feet
Cable tools 1317 to end.
Casing: 6-5/8" - 1317 feet - Formation shut off with packer.
Sand Record:

Sand (logged as water sand but probably 850-foot gas layer)	1080-1087 feet
Sand (tested water (Wilson?)	1556-1561 "

Still drilling.

Keouchan and Hurst, Colbert 1, Sec. 25, T2S, R8W.

Completed July 5, 1919 - Rotary tools.
Sand: - All pulled.
Sand Record:
No sands of interest.
Depth - 1620 feet
Dry hole - Abandoned.

Comanche Petroleum Co., Leolena Johnson 1, Sec. 20, T2S. R7W.

Completed April 14, 1919 - Rotary tools
Casing: 6-5/8" - 877 feet - Formation shut off.
Sand Record:
Gas sand 877 to 880 feet.
Initial production - 4 million cu. ft. dry gas.
Rock pressure 310 lbs.

Comanche Petroleum Company, Bristow 2, Sec. 18, T2S, R7W.

Completed July 22, 1919 - Rotary tools.
Casing: 6-5/8" - 837 feet approximately - Formation shut-off.
Sand Record:
Gas sand 837-844 feet.
Initial production - 2 million cubic feet per day dry gas.
Rock pressure 250 lbs.

Comanche Petroleum Co., Leolena Johnson 2, Sec. 32, T2S, R7W.

Casing pulled.
All sands carried water - Nothing of interest reported.
Dry hole - Abandoned.

Magnolia Petroleum Co., Brown 1, Sec. 20, T2S, R7W.

Drilling: Rotary tools 0 to 1325 feet
Cable tools 1325 to 1475 "
Rotary tools 1475 to ?
Casing: 6-5/8" - 1325 feet - Cemented.
Sand Record:

Hard gray sand - gas showing	415-445 feet
Sand showing gas	980-986 "
Sand - slight show of oil	1356-1358 "

Magnolia Petroleum Co., Dobbs 1, Sec. 7, T2S, R7W.

Drilling: Cable tools
Casing:
15½" - 60 feet
12½" - 605 "
10" - 1243 "
8¼" - carrying
Sand Record:

Water sand	585-605 feet
Water sand	666-678 "
Gas and water sand	1011-1024 "
Water sand	1107-1122 "
Salt water sand	1375-1385 "

Magnolia Petroleum Co., Chas. Andreae 1, Sec. 24, T2S, R8W.

Suspended - cemented. Rotary tools 0 to 1396 feet
Cable tools 1396 to ?
Casing: 6-5/8" - 1396 feet - Cemented.
Sand Record:
Hard sand - showed gas 235-265 feet
Hard sand - showed gas 300-395 feet